Rocky Flats
Environmental Technology Site

4-X60-SMP-3001

REVISION 0

QUANTIFICATION OF HOLDUP

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1. PURPOSE

This procedure describes the elements of the Safeguards Measurements (SM) holdup program. This procedure supplies job aids for evaluating non-routine holdup measurement locations. This procedure is intended to allow operational freedom to evaluate and measure holdup based on the supplied information. This procedure describes suggested measurement techniques which can be employed independently or in combination. Safety requirements and prerequisites are expected to be followed completely.

2. SCOPE

This procedure applies to holdup measurements not described in procedure 4-G77-SMP-SURV-003, Exhaust Ductwork System Fissile Material Holdup Annual Surveillance. This procedure is written for the level of expertise and training required by the Safeguards Measurements Holdup Team Qualification Program. It is not to be used without a minimum of 1 qualified Safeguards Measurements Holdup Team member.

This procedure addresses the following:

- Detector and Measurement Geometry Selection
- Specific applications
- Measurement Quality Assurance
- Instructions

3. OVERVIEW

Safeguards Measurements Holdup Team (SMHT) is responsible for determining the amount of Special Nuclear Material (SNM) holdup remaining in the process areas throughout the Rocky Flats Environmental Technology Site (RFETS). Plutonium, uranium, and americium residues deposited as a result of processing operations, can be detected and quantified using calibrated non-destructive assay (NDA) equipment. This procedure describes the equipment and methods utilized by the SMHT to accomplish holdup measurements. The procedure also prescribes the techniques used to ensure that these measurements meet quality assurance requirements of DOE Order 5633.3B.

4. LIMITATIONS AND PRECAUTIONS

WARNING

High voltage shall be set to zero before connecting or disconnecting detectors to prevent personal injury or electronic component damage from electrical shock.

(HSP 15.00, Electrical Safety Practices)

The height of many of the exhaust systems to be measured for SNM holdup requires measurement personnel to employ the use of ladders and/or scaffolding. Normal ladder/scaffold safety, as referred to in HSP 22.02, will be exercised by SM holdup measurement personnel when using ladders or scaffolds to access hard to reach ductwork..

The handling of Special Nuclear Material (SNM) shall be in accordance with the Safeguards and Accountability Manual and with applicable Nuclear Materials Safety Limits and Criticality Safety Operating Limits.

The handling of nuclide sources shall be in accordance with 1-61100-HSP-18.04, Control of Radioactive Sources.

The foil source used in calibration and listed on the Calibration Tag shall have the same identification number as the foil source used in adjustments and foil checks during data acquisition.

5. PREREQUISITE ACTIONS

5.1 Planning and Coordination

[1] Verify that the planned activity is scheduled on the applicable building Plan of the Day.

[2] Verify the applicable Shift Manager has authorized the performance of the procedure.

5.1 Planning and Coordination (continued)

[3] Ensure that pre-evolution briefing requirements are met in accordance with 1-31000-COOP-011, Pre-Evolution Briefing.

[4] Ensure that a qualified Safeguards Measurements Holdup Team member is present to perform this procedure. All tasks requiring use of ladders or scaffolding or in areas not occupied by other personnel shall be staffed with a minimum of two people.

[5] Verify that all calibrated equipment has current calibration tag.

[6] Ensure that all foil sources obtained for measurement which were used for calibration are specified by calibration tag.

[7] Ensure that data acquisition systems (DAS) employed for quantification have been calibrated in accordance with 4G75-SMP-CAL-001, BGO DAS Calibration for Holdup Measurements, and/or 4-G76-SMP-CAL-002, HPGe DAS Calibration for Holdup Measurements.

5.2 Materials and Equipment

SM Personnel

[1] Ensure that a calibrated DAS is available with a minimum of the following components.

- Detector
- Portable multi-channel analyzer (PMCA)
- Cables

[2] Obtain the following as needed:

- battery packs or chargers
- data recording forms
- lead or tungsten shielding
- computer

6. DETECTOR AND MEASUREMENT GEOMETRY SELECTION

The work of holdup measurement requires detection skills. A thorough walkdown of the item(s) to be measured is the best tool for applying the detection skills needed to tailor a specific measurement plan. Multiple detector types and geometry models can be included in the plan. Use of several geometry models is useful in validating assumption made in a single geometry selection. Since plant drawings are often inaccurate, sketches are recommended to assist the data reduction personnel.

6.1 Measurement Walkdown

Walkdowns are fact seeking missions and are useful as snapshots in time. They provide numerous clues for developing the best measurement plan. The following information should be considered.

[1] Dimensions are required for the item to be measured. If the item does not appear to have homogeneous holdup, specific dimensions of components or sections may be required.

[2] Accessibility can be a primary consideration in determining measurement locations.

[3] Composition of attenuationing materials should be determined whenever possible.

[4] Background concerns should be evaluated. When possible, sources of elevated background should be removed from the vicinity.

The Conduct of Engineering procedure for Engineering Walkdown Package (EWP) Preparation offers useful information for documenting walkdown information and should be used for a guide where applicable.

6.2 Detector Selection

Limited physical access to measurement locations can influence detector selection. A specific procedure for the choice of detector system and the geometry for all possible measurement points cannot be developed. The following guidelines are open to the interpretation of the Safeguards Measurements Holdup Team.

Holdup measurements can be accomplished with either the high purity germanium (HPGe) DAS or the bismuth germanate (BGO) DAS. However, if the minimum distance from the detector to the measurement location can not be adhered to, the use of the line approximation geometry is not recommended. Following the recommended four times the deposit width distance guideline ensures the entire deposition of SNM in the line source is accounted for in measurements.

A combination of detector systems may be used to measure a line source, but at least 20 consecutive feet should be available in order to make the use of the HPGe DAS practical. The measurement team will make the selection of the optimum measurement equipment (DAS) and the most appropriate approach to specific measurement points. The selection will be based on advice and consultation with other Safeguards Measurements Holdup Team members.

The following formula is used to approximate the minimum optimum distance between measurement points when utilizing a DAS for line geometry measurements: P2 = P1 + [D1(1/2)] where P1 = point of assay, D1 = distance from detector to pipe at P1 (point of assay), and P2 = next point of assay.

6.3 Geometry selection

The specifics of individual measurement points are unique to each point and a determination must be made as to the choice of geometry to be used for the data reduction. There are three possible geometries available to describe individual measurement points when using the DAS. Any of the three approximation geometries are acceptable provided that there is no other source of gamma rays in view of the detector. This means specifically, that the area behind the deposit to be measured should not contain any other possible areas of accumulation within the detector field of view (FOV). If such areas exist then the detector must be positioned to exclude them, or another geometry must be chosen to preclude the measurement of these possible background sources.

6.3 Geometry selection (continued)

For holdup measurements, there are three approximation geometries; the line approximation, the area approximation, and the point approximation. The geometries are defined as follows:

1. Point approximation geometry - the deposit or assay point is small in relation to the detector FOV;
2. Line approximation geometry - the holdup deposit ('line') is OPTIMALLY less than 25% of the height of the detector field of view (FOV) and spans the entire width of the detector FOV (a ratio of 1:1/2 the distance from detector to source approximately determines the effective detector FOV);
3. Area approximation geometry - the deposit or area to be measured covers the entire detector FOV.

7. SPECIFIC APPLICATIONS

Each holdup measurement situation is unique and must be evaluated individually. The following are suggested measurement plans. Specific location concerns may invalidate their use.

Measurement team personnel must ensure that the DAS to be used, either HPGe or BGO/NaI, has been calibrated in accordance with section 6 of this procedure. It must also be confirmed that the individual DAS components are identical to those used during the calibration.

Individual components of a calibrated DAS cannot be separated or substituted without a recalibration being performed. The components of a DAS which cannot be separated or substituted for after a DAS calibration are:
HPGe DAS

1. The detector, preamplifier, collimator/shielding combination;
2. The PMCA; and
3. The portable computer.

BGO/Sodium Iodide (NaI) DAS

1. The internally collimated detector;
2. The preamplifier; and
3. The PMCA.

7.1 Heat Chambers and Plenums

NOTE: *The portable computer utilized as a DAS component for both HPGe detectors and BGO/NaI detectors should contain the appropriate parameter file, generated during the detector calibration, for the detector that will be used. These parameter files are verified, installed, and recorded..*

[1] If a heat chamber or plenum can be measured from the bottom, then a grid of locations should be labeled and assayed. Due to the limited number of accessible locations assays and count rate, 200 second count time is often preferable.

[2] If screens or filters are present, then they should be assayed such that the screen area fills the detector FOV.

[3] If measurements from the bottom are not accessible, then assays from the top are preferable to assays from the side for determining floor accumulations.

7.2 Tanks

[1] If confirmatory measurements of tanks are performed, then SMHT desktop procedure 96-886-01 or SMHT Desktop procedure 3006 should be used as a job aid.

[2] If initial measurements of tanks are required, model selection requires consideration of the possible presence of Rashig rings and solution in the tank.

[3] Measurements should be made above and below possible solution levels, at 90 degree rotation around the tank circumference where appropriate.

[4] To minimize difficulties estimating the tank wall attenuation corrections, measurements should be made at a fixed distance of 1 inch, where possible, and perpendicular to the tank wall.

[5] Measurement locations should be labeled for future use.

7.3 Gloveboxes

[1] If all locations in a glovebox can be assayed by measurement through gloveports, then gloveports should be selected for assay locations. Considerations of the holdup geometry should be documented in the comment section of the data log.

[2] If equipment is present in the glovebox, record comments of which measurements include the equipment in the detector FOV and what the equipment geometry is.

[3] Auxiliary equipment, such as criticality safety drains, external pumps, etc., should be scanned and measured when the scan rate result is above area background rate.

7.4 HEPA Filters

[1] If the material processed by the exhaust system that generated the filters is not known to process only plutonium, then the HPGe DAS should be used.

[2] If the filter is a first stage filter, then count time of 200 seconds is recommended.

[3] Filters from plenum stages other than the first stage should be counted for 100 seconds unless special requirements exist.

[4] For standard size HEPA filters, position the detector perpendicular to the filter side 17 inches from the center of the filter.

[5] Both sides of all filters should be assayed.

7.5 Miscellaneous Items

[1] Measurements of requested items are evaluated during the walkdown and round table discussions are held to develop a measurement plan that is adequate to meet the requirements of the requester.

[2] As a minimum, for facility characterization, each room should be scanned with a moving scan of all equipment.

[3] For each scan, a background measurement in the same room is required.

8. MEASUREMENT QUALITY ASSURANCE

Specified time periods and frequencies for the performance of measurement control and routine instrument checks are maximum time intervals. For example, control measurements may be conducted weekly or instrument check measurements may be conducted multiple times in a single day. A minimum quality assurance program is defined in this section; however, special circumstances may dictate alternative measurement schedules.

8.1 Measurement Control

Bi-weekly measurement control is designed to assure measurement equipment accuracy and precision over extended periods of time (weeks).

[1] Perform bi-weekly verification of calibration of BGO/NaI systems in accordance with Section 8 of Procedure 4-G75-SMP-CAL-001, BGO DAS Calibration for Holdup Measurements.

[2] Perform bi-weekly verification of calibration of HPGe systems in accordance with Section 8 of Procedure 4-G76-SMP-CAL-002 HPGe DAS Calibration for Holdup Measurements.

8.2 Instrument Checks

Instrument check measurements are designed to ensure the operational stability of the measurement system over a short period of time (hours).

At a minimum, instrument checks are required to be performed daily prior to any Pu holdup measurements, and following five (5) top and bottom or ten (10) single assays.

The daily instrument check control limits for a particular DAS are printed on the calibration Tag for each system.

If the measured value falls outside the established two sigma control limits, a second measurement must be performed. If the remeasurement fails, ALL measurements performed following the last acceptable Daily Instrument Check must be RE-ASSAYED.

9. INSTRUCTIONS

9.1 EQUIPMENT DESCRIPTION

References are made to specific pieces of equipment, but it is understood that these references are made for reasons of practical application and are not intended to define a particular piece, or supplier, of equipment for which an effective substitute can be found. There are two data acquisition systems (DAS) utilized for accomplishing holdup measurements. The two DAS consist of a portable multichannel analyzer (PMCA) with an integral high voltage power supply; preamplifier; and either a High Purity Germanium (HPGe) detector or a lower resolution detector. Either of the DAS systems provide the desired resolution and detection levels required for holdup measurements. SM is presently employing Bismuth Germinate (BGO) detectors as the lower resolution detectors, however Sodium Iodide (NaI) detectors are essentially operationally interchangeable and may be used in the future. Because BGO and NaI detectors are operationally the same, for the purposes of this procedure, the lower resolution detectors will be referred to as BGO/NaI.

9.2 BGO/NaI

Sections 9.2 and 9.3 are stand alone sections and can be selected at the discretion of the trained and selected SM Personnel.

[1] Record the following by computer or paper entry.

Personnel 1

Personnel 2 (if Required)

Date

Detector #

[2] If performing ductwork measurements, then program BGOASSAY use is recommended.

[3] If performing measurements of equipment, then Sections 7, Measurement Geometries and Section 8, measurement considerations are recommended.

[4] The measurement procedure for the BGO/NaI DAS is essentially the same as that detailed for the HPGe DAS, with the notable exception that the normal acquisition time for BGO/NaI DAS is established at 100 seconds. However, the acquisition time may be based upon the activity seen at the measurement point. That is, the less activity seen, the longer the count time to ensure adequate statistics for data reduction.

9.3 HPGe DAS

NOTE 1: *Use of the HPGe detector is required for cases where isotopic characterization is determined to be needed.*

NOTE 2: *If the HPGe DAS is used to quantify holdup, then the system must be calibrated.*

[1] Record the following by computer or paper entry.
Personnel 1
Personnel 2 (if Required)
Date
Detector #

[2] Count time should be sufficient to yield good measurement statistics. Lower count rates require longer count times.

NOTE: *To view peaks better, Select SCALE, and choose LOG.*

[3] Selected Peaks of interest are (in keV):

59.5	241Am	129.3	239Pu
185.7	235U	208	239Pu
332	Am	413.7	239Pu

[4] Assay measurements proceed by maintaining the background measurement position, removing the shield, and acquiring a spectrum.

NOTE: *Normal acquisition time for HPGe DAS is established at 300 seconds. However, the acquisition time may be based upon the activity seen at the measurement point. That is, the less activity seen, the longer the count time to ensure adequate statistics for data reduction.*

9.4 Detector Positioning

NOTE 1: *To avoid damage to any part of the DAS, the system components must be moved carefully. Positioning should consider dead time and possible external sources of interference.*

NOTE 2: *After assembling the DAS, and complying with the appropriate system setup, measurement control, and the instrument check portions of this procedure the holdup measurement process may commence. SM personnel attempt to model the extent of the holdup. Where possible, measurements are taken such that all holdup locations are in a measurement FOV.*

[1] In order to use the `line approximation geometry', the detector must be positioned directly perpendicular to the item to be measured. To ensure an accurate physical location of this position, a `plumb bob' can be used.. An accurate detector to holdup distance measurement is required for the use of this geometry.

[2] In order to use the `point approximation geometry', the deposition to be measured must appear small in relation to the detector FOV, and must also be the only radionuclide source within the detector FOV. An accurate detector to holdup distance measurement is required for the use of this geometry.

[3] In order to use the `area approximation geometry', the deposition to be measured must fill the entire detector FOV, and must also be the only radionuclide source within the detector FOV. No distance measurement is required for the use of this geometry.

NOTE: *To avoid damage to any part of the DAS, the system components must be moved carefully.*

10. POST-PERFORMANCE ACTIVITY

All software used in these measurements is handled in accordance with 4-F14-SMP-ADM-3002, Software Management for Holdup Data Acquisition Systems.

10.1 Records Disposition

Measurement Personnel

All data records generated by this procedure are Quality Assurance Records.

[1] Sign and record date and DAS number on applicable data form.

[2] Forward the applicable data form to the Safeguards Measurements Holdup Team Data Analyst.

Data Analyst

[3] Review the applicable data form for completeness.

[4] Submit to Independent Reviewer for review following data analysis

Independent Reviewer

[5] Sign data form to verify review.

[6] Forward the applicable forms to Data Analyst for filing.

Data Analyst

[7] File the applicable data form in accordance with 1-77000-RM-001, Records Management Guidance for Records Sources.

[8] Copies of all holdup measurement results other than routine, confirmatory results will be transmitted to the appropriate Operations Manager and the designated Criticality Safety Contact.

11. REFERENCES

HSP 15.00, Electrical Safety Practices

1-N72-HSP-18.00, Radiological Control Policy and Responsibilities

1-31000-COOP-011, Pre-Evolution Briefing

4-F14-SMP-ADM-3002, Software Management for Holdup Data Acquisition Systems

1-77000-001, Records Management Guidance for Records Sources

2-D80-COEM-DES-221, Engineering Walkdown Package (EWP) Preparation

4-G75-SMP-CAL-001, BGO DAS Calibration for Holdup Measurements

4-G76-SMP-CAL-002, HPGe DAS Calibration for Holdup Measurements

Safeguards Measurements Holdup Measurements Training Program

RFP Nuclear Safeguards Manual